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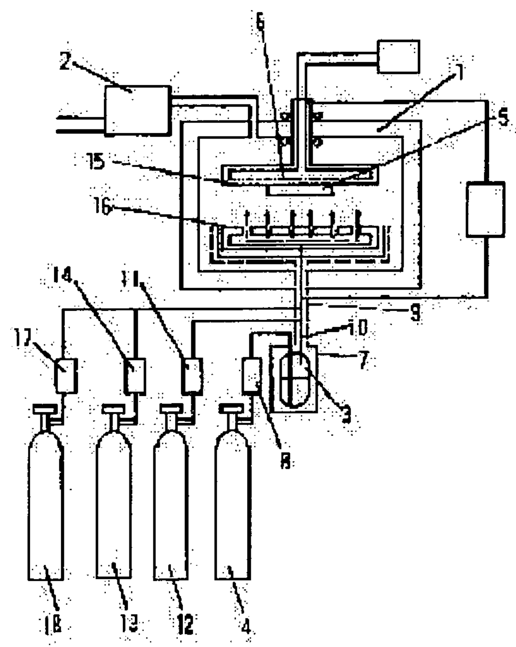
(54) PRODUCTION OF THIN TANTALUM OXIDE FILM

(57)Abstract:
PURPOSE: To obtain a thin tatalum oxide film of high dielectric constant under controlling the thickness of a SiO2 film present at the interface to a low level.
CONSTITUTION: The surface of a polysilicon substrate 5 is treated, in a vacuum chamber 1, with hydrogen 13 and argon gas 18's plasma to remove the naturally oxidized film on this surface. Ta(OC2H5)5 in an ampul 3 is bubbled by Ar inert gas 4 and introduced into the vacuum chamber 1 where the compound is thermally decomposed and built up as a thin tantalum oxide film of low oxidation degree on the substrate 5; O2 gas 12 is then introduced into this chamber followed by application of electric field between electrodes 15 and 16, and the above thin film is irradiated with the resultant O2 gas put to plasma decomposition, thus promoting oxidation.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention relates to the manufacture technique of a tantalum oxide thin film useful as capacitive insulator layers, such as DRAM (dynamic random access memory) and a capacitor, etc.
[0002]
[Description of the Prior Art] For the CVD (chemical-vapor-deposition method) which is made to carry out the thermal decomposition reaction of the material gas within a vacuum chamber, and forms a thin film on a substrate to attract attention as a useful means of thin film formation, such as a semiconductor and a dielectric, to be with a CVD system also in the formation technique of a useful tantalum oxide thin film as a capacitive insulator layer etc., and to manufacture a thin film by the chemical-vapor-deposition method in recent years is tried. In this case, the so-called heat CVD system which has the vacuum chamber which can usually be heated is used.
[0003] Hereafter, the manufacture technique of the conventional tantalum oxide thin film is explained, referring to a drawing. Drawing 2 is a schematic diagram showing the configuration of the tantalum oxide thin-film-fabrication equipment (CVD system) used for the tantalum oxide thin film forming method by the conventional CVD.
[0004] A manufacture of the tantalum oxide thin film by the former and the CVD system is Ta5 of a liquid (OC2 H5) as a raw material. It has been formed using a liquid organic tantalum compound, oxygen gas, etc. which are represented with a grade.
[0005] In drawing 2 , a vacuum chamber 31 is usually exhausted by the vacuum of about 0.5-10 Torrs with the evacuation equipment 32. Ta5 which is a tantalum raw material in ampul 36 (OC2 H5) It is inert gas 39 by which the temperature control was carried out to 130 degrees C, and control of flow was usually carried out to 100 - 1000sccm at the heater 37, such as helium and Ar. Ta5 in ampul 36 (OC2 H5) It is introduced into the gas introduction spool 41 heated by 150 degrees C at the heater 40 by carrying out a bubbling. A tantalum raw material is introduced in a vacuum chamber 31, and the oxygen gas 43 by which control of flow was carried out to 100 - 1000sccm with the control-of-flow equipment 42 is also simultaneously introduced in a vacuum chamber 31.
[0006] The pyrolysis reaction of these material gas introduced in the vacuum chamber 31 is carried out, and a tantalum oxide thin film deposits it on the substrate 33 currently heated by about 450 degrees C at the heater 34. The deposited tantalum oxide thin film is usually O2. Or O3 It is heat-treated at the temperature of 450 to 800 degrees C in inside.
[0007]
[Problem(s) to be Solved by the Invention] However, SiO2 which contest polysilicon which is a substrate oxidizes during deposition of a tantalum oxide thin film, or heat treatment, and exists in an interface by such technique The thickness of a layer will become thick. This is O2 in a vacuum chamber 31. These O2 [immediately after introducing gas] What is depended on that substrates, such as contest polysilicon, oxidize by gas, the thing which oxygen gas diffuses the inside of the tantalum oxide thin film under deposition, and substrates, such as contest polysilicon, oxidize, the oxygen which is the generated constituent of tantalum oxide reacting with substrates, such as contest polysilicon, and joining together, etc. is presumed.
[0008] Therefore, SiO2 It is SiO2 in the two-layer structure by the layer and the oxidization **** thin film. There was a trouble where a rate increased and a dielectric constant fell. this invention is SiO2 which exists in an interface. The thickness of a layer is controlled and it aims at offering the manufacture technique of the tantalum oxide thin film which can form the capacitor with a large capacity which was excellent in the dielectric constant.
[0009]
[Means for Solving the Problem] The manufacture technique of the tantalum oxide thin film of this invention as material gas in order to attain the aforementioned purpose An organic tantalum compound, In the manufacture technique of the tantalum oxide thin film by the chemical-vapor-deposition method which carries out a pyrolysis reaction within a vacuum chamber using an inorganic tantalum compound, as material gas in the aforementioned vacuum chamber Or the aforementioned organic tantalum compound or an inorganic tantalum compound, O2 which carried out plasma decomposition after forming a tantalum thin film or the tantalum oxide thin film of bottom-acid-izing by introducing and carrying out the pyrolysis reaction of the inert gas Or O3 which carried out plasma decomposition It is characterized by irradiating.
[0010]
[Function] The manufacture technique of the tantalum oxide thin film of this invention as material gas An organic tantalum compound, In the manufacture technique of the tantalum oxide thin film by the chemical-vapor-deposition method which carries

out a pyrolysis reaction within a vacuum chamber using an inorganic tantalum compound, as material gas in the aforementioned vacuum chamber Or the aforementioned organic tantalum compound or an inorganic tantalum compound, O2 which carried out plasma decomposition after forming a tantalum thin film or the tantalum oxide thin film of bottom-acid-izing by introducing and carrying out the pyrolysis reaction of the inert gas Or O3 which carried out plasma decomposition Since it irradiates In order that substrates, such as contest polysilicon, may not oxidize during a tantalum thin film or tantalum oxide thin film membrane formation of bottom-acid-izing, it is SiO2 to an interface during tantalum oxide thin film deposition of a tantalum thin film or bottom-acid-izing. It is hardly formed. Therefore, the tantalum oxide thin film which was excellent in the dielectric constant which can form the capacitor with a large capacity can be formed.

[0011] Moreover, O2 which carried out plasma decomposition after forming a tantalum thin film or the tantalum oxide thin film of bottom-acid-izing Or O3 which carried out plasma decomposition Since it irradiates, it is these O2 that carried out plasma decomposition. Or O3 which carried out plasma decomposition By controlling the temperature and time of oxidation reaction by irradiating, it is SiO2 of an interface. The thickness of a layer is also controllable.

[0012]

[Example] Hereafter, although this invention is further explained concretely using the example of this invention, this invention is not limited only to a publication of these examples.

[0013] Drawing 1 is a schematic diagram of the tantalum oxide thin film deposition system used in the example of this invention. 1 is a vacuum chamber and is exhausted by the vacuum with the evacuation equipment 2. 5 is the substrate installed in the vacuum chamber, and used contest polysilicon in this example. The substrate 5 is heated by about 450 degrees C at the heater 6. Since the natural-oxidation layer has accumulated on substrate 5 front face, with H2 13 (this example about 100 sccms) by which control of flow was carried out with the control-of-flow equipment 14, and the control-of-flow equipment 17, the Ar gas (this example about 300 sccms) 18 by which control of flow was carried out is introduced in a vacuum chamber 1, a pressure is adjusted to about about 1 Torr, a plasma is generated among electrodes 15 and 16, and the natural-oxidation layer on a polysilicon contest is removed.

[0014] Ta5 which is an organic tantalum compound in ampul 3 (OC2 H5) A bubbling is carried out by the inert gas 4 (Ar was used in this example) by which the temperature control was carried out to 120 degrees C by the thermostat 7, and control of flow was carried out with the control-of-flow equipment 8, such as helium and Ar, and it is introduced into a vacuum chamber 1 through the gas introduction spool 10 heated by about 150 degrees C at a heater 9. The pyrolysis reaction of the material gas introduced into the vacuum chamber 1 is carried out, and the tantalum oxide thin film of bottom-acid-izing deposits it on a substrate 5.

[0015] The tantalum oxide thin film of deposited bottom-acid-izing is held in a vacuum chamber 1. The oxygen inclusion gas 12 by which control of flow was carried out with the control-of-flow equipment 11 is introduced in a vacuum chamber 1 (in this example, 500sccm introduction of O2 was carried out), among electrodes 15 and 16, the electric field are ****ed and gas is understood by the plasma. O2 which carried out plasma decomposition by it at the tantalum oxide thin film of the aforementioned bottom-acid-izing It irradiates and oxidization is promoted.

[0016] Table 2 is O2 which carried out plasma decomposition although it applied to the technique of the tantalum oxide thin film formed by the conventional example, and this example, and the technique of this example. The dielectric constant of the tantalum oxide thin film formed by the technique at the time of not irradiating etc. is shown.

[0017] A in Table 2 is O2 which carried out plasma decomposition. B is O2 when not irradiating. The dielectric constant at the time of irradiating a plasma for 5 minutes (substrate temperature of 450 degrees C) is shown. O2 which carried out the plasma decomposition of any sample The 100A tantalum oxide thin film or the bottom-acid-ized tantalum thin film was deposited in the state of irradiation un-processing. Membrane formation conditions were shown in Table 1. What is depended on the technique (however, * is attached by the case where O2 irradiation which carried out plasma decomposition is not carried out.) according to the example in the case of A has a dielectric constant higher than what is depended on the conventional example, and since oxidization of a thin film is promoted by performing B processing, it turns out that a dielectric constant becomes high further.

[0018]

[Table 1]

	酸素流量 (sccm)	アルゴン流量 (sccm)	基板温度 (℃)	圧力 (Torr)
従来例	500	300	450	1
実施例	0	300	450	1

[0019]

[Table 2]

	誘電率	
	A	B
従来例	10.11	———
実施例	14.40*	17.43

[0020] In addition, as an example of an organic tantalum compound, they are Ta (OCH3)5, Ta (OC3 H7)5, Ta (OC4 H9)5, 2 (C5 H5) TaH3, and Ta (N(CH3) 2)5 besides Ta (OC2 H5)5 in this invention. A grade is mentioned. As an inorganic tantalum compound, they are TaCl5 and TaF5, for example. A grade is mentioned.
[0021] As a pressure in a vacuum chamber, the domain of about 0.5-10 Torrs is common, and although it does not limit especially as inert gas, Ar and helium are usually used, and it is N2. It can use. Moreover, it is O3 as oxygen inclusion gas. When using, it is usually O2. It is O3 easily by the ozonizer (ozonization equipment). It can carry out.
[0022] Moreover, although it does not limit especially about the flow rate of these inert gas or oxygen inclusion gas, the domain which is about 50-1000 sccms is suitable.
[0023]
[Effect of the Invention] this invention is SiO2 of the interface of contest polysilicon which is a substrate, and a tantalum oxide thin film. It can consider as a very thin thing and the manufacture technique of the tantalum oxide thin film with a high dielectric constant can be offered.

[Translation done.]